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Effectively harnessing science, technology and innovation to achieve the Sustainable Development Goals

Executive summary

The 2030 Agenda for Sustainable Development requires a transformation that will not be possible without a sustained effort to close the technological gaps between developed and developing countries. Technology and innovation must contribute to all three dimensions of sustainable development – economic, social and environmental. Science, technology and innovation (STI) policy frameworks will need to consider new societal challenges, involve new actors, consider broader concepts of innovation systems and deploy alternative approaches to innovation. This note suggests about how those new policy frameworks could be delineated and offers for consideration by the Multi-year Expert Meeting on Investment, Innovation and Entrepreneurship for Productive Capacity-building and Sustainable Development, possible changes that could help align UNCTAD technical cooperation in this area, namely the STI policy review programme, with the Sustainable Development Goals.

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Introduction

1. STI policy for development should be consistent with the global development framework provided by the 2030 Agenda for Sustainable Development, within which economic growth, social inclusion and environmental sustainability support and reinforce each other. To achieve this, it is imperative to close the gaps in technological and innovative capabilities that separate developed and developing countries. Further, developing countries must set out on a path of technological convergence. This is the rationale that makes STI, in synergy with other defining issues of the mandate of UNCTAD, such as trade or finance, one of the key means of implementing the 2030 Agenda that are identified in Sustainable Development Goal 17.[1]

2. However, technological catch-up would not suffice to deliver fully on the 2030 Agenda. The Sustainable Development Goals incorporate an aspiration of economic, social and environmental transformation that is unlikely to be realized unless countries embark on new development trajectories that do not perpetuate the historical pattern of environmental degradation or increased inequality. This means that STI policy will need to involve new actors, address broader concepts of innovation systems and deploy new approaches to innovation.

3. UNCTAD supports developing countries in formulating STI policies that enable and stimulate technological development, diffusion and transfer. Reflecting the increased awareness of the central role of STI for the achievement of the global development agenda, the outcome of the fourteenth session of UNCTAD mandates the Organization to strengthen its work on technology along several lines, including its STI policy reviews, so that they support actions leading to sustainable development. The United Nations Commission on Science and Technology for Development, which UNCTAD services, has also contributed to the definition of the STI policy review programme and has provided a forum for the dissemination and analysis of the outcome of such reviews. In its recent deliberations, the Commission has called on UNCTAD to broaden the framework for its STI policy reviews to integrate the Sustainable Development Goals.

4. This note presents for consideration by the Expert Meeting several elements that could define new frameworks for STI policy for development – including for UNCTAD work in the STI policy review programme – that are better aligned with the 2030 Agenda and the Sustainable Development Goals. The central question is how and to what extent innovation policy can orient innovation, creating synergies between economic development, social inclusiveness and environmental sustainability so that it contributes to building productive capacity in developing countries, while addressing the societal challenges that underpin the Goals. In this respect, STI policy reviews should become more useful instruments to support STI policymaking by assessing the effectiveness of STI policies and identifying priorities for action for sustainable development and the Sustainable Development Goals.

5. The remainder of this note is organized as follows: Section II looks at the role of STI in the implementation of the 2030 Agenda. Section III considers how innovation systems, the most current analytical and operational framework for innovation policy, could be reconsidered to make them more relevant to the transformative agenda embodied in the Sustainable Development Goals. Section IV presents some ideas about how the STI policy work of UNCTAD, in particular the STI policy reviews, could be improved to make them more supportive of the 2030 Agenda.

I. Harnessing the potential of science, technology and innovation for sustainable development

6. The main document framing the global development agenda is entitled "Transforming our world: The 2030 Agenda for Sustainable Development" (A/RES/70/1).

[1] Goal 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

The 2030 Agenda recognizes the eradication of poverty as the greatest global challenge and an indispensable requirement for sustainable development. It also recognizes STI as a key driver enabling and accelerating the global transformation towards prosperous, inclusive and environmentally sustainable economies in developing and developed countries alike. STI features strongly among the Sustainable Development Goals. Goal 9 on infrastructure, industrialization and innovation explicitly mentions the role of fostering innovation and technological progress to promote inclusive and sustainable industrial development. Equally important is the strong potential of STI to contribute to the achievement of virtually all the other Goals. Lastly, Goal 17 places cooperation on STI at the heart of international cooperation and global partnerships for development.

7. Innovation has always played a fundamental part in economic development. In the long-term, growth in income per capita is determined by changes in productivity that are closely linked to technological progress and innovation. Even in the medium and short terms, considerable benefits are achievable by adopting modern technologies and innovative practices in developing countries. Access to information and communications technologies (ICTs), for example, improves the quality of life in the most remote areas of the world by enabling people to communicate, learn and run their businesses more effectively. Biotechnology and precision farming – enabled by technologies such as geolocation, drones, smart sensors and cloud computing – can improve yields and farmers' livelihoods in regions challenged by adverse climatic conditions. Renewable energy technologies are diffusing at an impressive pace and provide broader access to electricity, which is a prerequisite for productive upgrading and a means to deliver on many other development targets in areas such as health, gender or education. Environmental technologies help tackle harmful emissions and improve energy efficiency in manufacturing sectors.

8. While it is unquestionable that technological innovation holds great potential for delivering benefits to businesses, societies and the environment, it is not because the advantages of technologies are so large that they will be necessarily adopted, or on the large scale that is required, without explicit national policies supported by sufficient national and international investments and effective mechanisms to ensure the facilitation and transfer of technology. In any case, all innovation – including that with the most potential benefits – involves some economic, social or environmental trade-offs that should be identified, evaluated and addressed.

9. These are complex tasks for which countries need to be able to draw on knowledge and institutional resources that remain weak in many developing countries. Without these resources, it would be difficult to impart the policy stimulus to initiate and direct change. In some countries, there is a circular trap of weak capacity, low attention and funding and a lack of real integration of STI in development strategy. This represents a formidable challenge, since latecomers are disadvantaged in a competition based on cumulative knowledge and skills, long-term interactions, and sophisticated material and immaterial infrastructure. Developing countries should therefore be supported in the development of coherent frameworks that connect proactive innovation efforts with, among others, trade, investment, competition and industrial policies. The participation of a broad set of socioeconomic actors in those frameworks will be crucial, given the ample evidence that success in addressing development challenges through innovation is related to the extent to which proposed solutions take into account local context and the values and practices of local communities.

10. How, then, can the potential of STI for inclusive and sustainable growth be harnessed more effectively? Insofar as modern innovation policy is based on a system perspective, the challenge of sustainable development could be approached by considering the socioeconomic and technical systems into which innovation is to be introduced in order to deliver the necessary change.

11. In this sense, the achievement of most Sustainable Development Goals will depend on the performance of systems for the production and delivery of food, energy, water, health care, education or transport. For example, tackling climate change requires a radical transformation of energy and mobility systems that implies changes in production and consumption patterns. This requires a variety of functionally connected innovations,

including new technologies, infrastructures, goods and services, processes, organizational and business models, education and training programmes, as well as new forms of governance and policy frameworks. The objective of STI policy aimed at tackling societal challenges is therefore to foster systemic changes with a potential for transformative impact.

II. Science, technology and innovation systems for sustainable development

12. The primary innovation challenge for developing countries is to develop their capacity to learn, adopt and diffuse existing and new knowledge and technologies to promote sustainable and inclusive development. Tapping into the potential of new and emerging technologies requires an environment that enables and nurtures learning and innovation. To reap more benefits from innovation, developing countries should devote resources, time and concentrated efforts to build and manage their national innovation systems.

13. Innovation systems theory should be used as a method to understand how STI affects socioeconomic development in a particular context (country or region) and as a framework for developing and implementing STI policy. Context is important. Innovation strategies can only be reproduced to a certain extent. Instruments and policies that have worked in a specific context to address a certain societal challenge might not be adequate in another system. There is no simple blueprint for building and managing an innovation system that can be replicated across countries. All national innovation systems, however, share common features that can be classified into three domains:

(a) Actors and stakeholders, and their capabilities;

(b) Networks, linkages and an environment that enables collaboration and learning;

(c) An enabling environment, including absorptive capacity, technological learning, adoption and diffusion.

14. To take a fuller account of the potential of innovation systems for addressing the Sustainable Development Goals, an innovation systems framework to assess and develop STI policy should include a comprehensive view of all types of innovation, new actors and partnerships, as well as a new and broader perspective on framework conditions and the environment of innovation in developing and developed countries.

A. Actors and stakeholders

15. Firms are at the core of any innovation system due to their central role in connecting different types of knowledge to bring innovative technologies, goods and services to the market.[2] Firms, however, are not the only innovators and they do not innovate in isolation. Firms, as well as other STI stakeholders, need to evolve their capacity to identify, adopt, assimilate and diffuse existing knowledge and technologies. Further, they need to increasingly immerse themselves in learning and innovation networks and invest in developing linkages.

16. Building absorptive capacity and technological upgrading often relies on access to and assimilation of foreign knowledge and technology by local actors. The same is true of assimilation of locally developed technologies by other local firms. Flows of relevant foreign knowledge can be enabled by different processes, including trade, foreign direct investment, licensing, migration, global value chains and imitation. Technology transfer cannot be successful without efforts to build a local absorptive capacity and should not replace efforts to build up endogenous innovation potential.

[2] S Metcalfe and R Ramlogan, 2008, Innovation systems and the competitive process in developing economies, *Quarterly Review of Economics and Finance*, 48(2):433–446.

17. To better benefit from STI, policymakers should recognize the roles and capabilities of all key actors in the innovation system:

(a) Firms and entrepreneurs: develop capabilities (technological and managerial) to learn, absorb, innovate by commercializing knowledge and technologies, and interact with other firms and STI stakeholders;

(b) Research and education system: develop learning abilities, critical thinking, problem solving, creative use of knowledge and technology, outreach to firms and industries, and human capital for the innovation system;

(c) Government: develop capabilities to forge and implement STI policy, engage in policy learning, decide on innovation policy priorities, provide support capabilities and stimulate networks and linkages among all STI stakeholders and throughout the innovation system;

(d) Civil society and consumers: capacity to understand challenges in STI, express and support broad concerns about sustainability and inclusiveness, and to learn, explore, adapt and adopt knowledge and innovative technologies.

18. Absorptive capacity is the ability of an economy and its entrepreneurs, firms and organizations to recognize the potential value of new or novel knowledge and technology, and to transfer and assimilate it to develop a commercially or socially viable good or service.[3] Absorptive capacity is fundamental for any effective innovation system. Its major determinants are the national knowledge base and the support and the incentives that STI policies provide for technological learning and innovation processes, and for the development of linkages between knowledge organizations and the productive sectors and public services.

19. The learning that STI policy should incentivize should be understood broadly, ranging from the capacity to identify, absorb and manage existing knowledge and technology (absorptive capacity) to the capability of firms to engage in advanced research and development and technological innovation. Firms' ability to engage in technological upgrading and as a result develop sectoral and national productive capacities, is a prerequisite for introducing innovations on the local, national and international markets.

20. The capability of actors in academia to generate and apply knowledge to innovation processes is key to technological learning and building the local knowledge base. Being relevant to the needs of industries, firms and consumers, and to the challenges of the Sustainable Development Goals, is critical. Depending on their scientific and technological competences and capabilities, actors in research can offer services to companies ranging from support for technology adoption (for example, testing) to fully fledged research and development and demonstration processes. The education system, including universities, training institutes and technical and vocational schools, can improve the quality of human capital available to firms, Governments and research institutions. It needs to respond to the changing demand for specific skills to improve learning capabilities and absorptive capacity of firms and other actors.

21. The capability of government to establish a consensus on development and STI policy priorities and build capabilities and linkages in the innovation system is key to the formation of any innovation system. Policymakers can deploy a range of instruments to directly support the development of a national innovation system. Establishing a national STI agenda and tackling market and systemic failures that inhibit the performance of an innovation system should be priority objectives. Governments play a key role in aligning STI priorities with the challenges of sustainable development and the Sustainable Development Goals. A coherent STI policy mix is crucial to provide a stable and predictable environment for innovation.

22. Civil society and citizens are increasingly considered key actors in innovation systems. The role of non-governmental organizations, social enterprises and engaged

[3] TD/B/C.II/21.

citizens is crucial for focusing STI policy on meeting societal challenges and assimilating new technologies. There is also growing evidence of the role of civil society in social and institutional innovations that ultimately might trigger technological change. Civil society can mediate between technology developers and marginalized groups and promote innovations that address social needs. In developing countries, civil society can be instrumental in testing, promoting and diffusing innovations designed to benefit the most disadvantaged communities.

B. Networks and linkages

23. Developing networks among STI actors is a necessary step in the creation of an innovation system. Effective innovation systems have robust and evolving linkages that enable organizations to translate new knowledge into innovations, enhance productive capacity and meet societal challenges. Networking and collaboration capabilities enable knowledge flows and learning among all STI stakeholders, particularly knowledge creators and users. Networking and linkages help stakeholders respond to the changing demand for skills and help improve the learning capabilities and absorptive capacities of firms and other actors. Further, they enable the flow of key resources, including finance and human capital.

24. Facilitating innovation collaboration in response to societal challenges requires relevant capacities and skills. Network collaboration takes many forms, ranging from information exchanges to the establishment of innovation partnerships or clusters, which can become actors on their own. Innovation intermediaries or knowledge and technology brokers specialize in facilitating the exchange of knowledge and collaborative work on innovation and are key elements in developing functional innovation networks.

25. STI policy should encourage local, national and international collaboration across economic sectors, technology areas and scientific disciplines. Building collaborative capabilities among national actors is fundamental for strengthening the endogenous potential of a country in the long term. Collaborative work along supply and value chains, including organizations that finance innovation, and the final users of new technologies ensure that innovation responds to demand, is socially accepted and has a better chance of succeeding on the market.

26. Developing links with foreign firms, funders and research centres is a key step for countries with an underdeveloped local knowledge base and limited access to market intelligence. For those links to deliver results, it is important that local firms have some technological capacity before creating links with foreign firms.

27. Collaboration among actors of innovation rarely emerges spontaneously in innovation systems that are not fully developed, as it is inhibited by multiple system failures. Particularly when addressing social and environmental challenges, collaboration requires active and coordinated action by government, often with other actors, notably non-governmental organizations. Government can support networking in specific locations (for example, technology parks) or sectors (for example, competence centres focused on specific topics). The emergence of successful innovation networks is a long-term process based on a shared vision, common goals and trust.

C. Enabling environment

28. STI policy frameworks should target the establishment of an enabling environment that facilitates the development of innovation capabilities and encourages actors to engage in innovation. There are five major elements in an innovation system that constitute an enabling environment for innovation:

(a) Regulatory and policy framework;

(b) Institutional setting and governance;

(c) Entrepreneurial ecosystem and access to finance;

(d) Human capital;

(e) Technical, and research and development infrastructure.

29. A well-designed and functional regulatory and policy framework provides incentives to established and emerging firms and organizations to invest in learning, knowledge and innovation. [4] Developing countries often suffer from insufficiently developed and fragmented STI policies, as well as regulations that act as disincentives for innovation. Policies should provide a stable and predictable environment to enable long-term planning by firms, the organizations financing technology and innovation, and other actors of innovation. This allows them to assess the uncertainty and manage risks involved in innovation. The regulatory and policy framework should be internally and externally coherent with other key policy areas. STI policy should seek congruence with policies relating to education, labour, industrial, trade, foreign direct investment and competition, as well as with overall development policy and the Sustainable Development Goals.

30. The institutional setting and governance includes laws, standards and norms in a society, along with governance mechanisms used to create, regulate and enforce them. Institutions should incentivize actors to invest in productive, rather than rent-seeking activities. A broader notion of governance would include new actors, including civil society and grass-roots movements. These actors would actively promote new forms of innovation (for example, pro-poor innovation), speak for community or environmental interests and be particularly concerned with specific Sustainable Development Goals.

31. Specialized bodies for financing technology and innovation are extremely important, given the common market failure of underinvestment in STI.[5] Other relevant organizations include education and training institutes, government ministries, departments and agencies overseeing STI policy, and organizations central to systems of metrology, standards, testing and quality.

32. An entrepreneurial support system that enables access to finance is key to encouraging the growth of innovative firms. Ensuring that promising innovative projects can receive financial support is not only a question of availability of funds, but also of organizational capabilities and policy frameworks. Firms and entrepreneurs should develop managerial competences to develop credible business plans and assess project risks. Organizations financing innovation for sustainable development should adapt their instruments to make them easier to access for firms with value propositions relevant to achieving development goals. Government can support this by promoting new financial instruments catered to the needs and capabilities of small and medium-sized enterprises and entrepreneurs, and adapting their coaching and support activities, as well as monitoring and evaluation criteria, to the ambitions of the 2030 Agenda.

33. Developing human capital allows a nation to engage in technology adoption and innovation processes. This is true of developed and urban regions, as well as the poorest and most remote communities. Human capital relies on all levels of education and includes technical and managerial skills involved in a variety of innovation activities ranging from research and development, design and engineering, to technology brokerage and networking. A strong technical and vocational, basic and higher education system must provide basic science, technology, engineering, mathematics and management skills. With new technologies, certain skills have become more essential – problem solving, teamwork, creativity and learning to learn, and ICT skills. Human capital development is also key to

[4] C Chaminade, B-A Lundvall, KJ Joseph and J Vang, 2009, Designing innovation policies for development: Towards a systemic experimentation-based approach, in B-A Lundvall, KJ Joseph, C Chaminade and J Vang, eds., *Handbook of Innovation Systems and Developing Countries* (Edward Elgar Publishing, Cheltenham, United Kingdom of Great Britain and Northern Ireland); UNCTAD, 2007, *The Least Developed Countries Report 2007: Knowledge, Technological Learning and Innovation for Development* (United Nations publication, Sales No. E.07.II.D.8, New York and Geneva); and World Bank, 2010, *Innovation Policy: A Guide for Developing Countries* (Washington, D.C.).

[5] C Edquist, ed., 1997, *Systems of Innovation: Technologies, Institutions and Organizations* (Routeledge, Oxford); UNCTAD, 2007, TD/B/C.II/21.

learning how to design and implement STI policies and develop effective institutions and organizations.[6]

34. Technical and research and development infrastructure comprises basic technical infrastructure, for example, water, energy, ICT, transport and urban structures. It also includes specialized infrastructure supporting research and development, demonstration and innovation processes (for example, laboratories, prototyping facilities, and testing and certification facilities), and existing technologies. Basic technical infrastructure is one of the key factors promoting innovation, as it reduces the cost of upfront investment for social entrepreneurs, organizations, start-up firms, and small and medium-sized enterprises; it also enables interaction and the exchange of information and knowledge locally and internationally.

35. ICTs have become a critical infrastructure for innovation. As enabling technologies, they create synergies with virtually all other technology sectors, including biotechnology, nanotechnology and advanced manufacturing. ICTs have a potential to contribute to all the Sustainable Development Goals. Taking advantage of this potential requires investments in infrastructure, including reliable energy supply and telecommunications infrastructure, particularly broadband connectivity. It also requires regulation ensuring a competitive marketplace to provide quality, affordable and accessible ICT services across geographic, gender, generational and income divides.

III. New science, technology and innovation policy frameworks for sustainable development

A. Broadening the scope of science, technology and innovation policy

36. To effectively support the transformative changes implied in the 2030 Agenda, STI policy should broaden its traditional focus on targets such as productivity growth and business competitiveness to address complex societal challenges that span the economic, social and environmental dimensions of development. It needs to provide a sense of direction to technological change and innovation that is consistent with sustainable and inclusive development. STI policy should also include in its considerations both the benefits and costs of technological change and innovation. This changes the rationale of STI policy and has significant implications for STI policy strategy, instruments, processes and governance.

37. In the early days of STI policy, notably during the decades following the Second World War, the rationale behind public intervention in STI was to mainly overcome market failure resulting in suboptimal levels of investments in research and development. The logic of public support relied predominantly on the science–push linear model of innovation. Since the 1980s, STI policies have evolved towards the innovation systems model that recognizes that innovation processes take place in networks of actors and institutions and depend on market and non-market stimuli. Literature on innovation systems introduced the notion of system failures that hamper innovation, such as capabilities of STI stakeholders, underdeveloped linkages and networks, and insufficient framework conditions (infrastructure, regulations and policy). More recently, a technological innovation system approach has been focusing on key innovation systems elements to explain the process of structural change and socioeconomic transformation.[7]

38. Addressing market failure and systems failure, that is to say, developing an innovation system, remains the main rationale for STI policies in most countries. The

[6] UNCTAD, 2007.

[7] A Bergek, S Jacobsson, B Carlsson, S Lindmark and A Rickne, 2008, Analysing the functional dynamics of technological innovation systems: A scheme of analysis, *Research Policy*, (37)3:407–429; MP Hekkert, RAA Suurs, S Negro, S Kuhlmann and REHM Smits, 2007, Functions of innovation systems: A new approach for analysing technological change, *Technological Forecasting and Social Change*, 74(4):413–432.

introduction of the ambitious and wide-ranging Sustainable Development Goals creates an opportunity for a major change in the rationale of STI policy. Designed with market and system failures in mind, current STI policy frameworks are concerned mainly with economic objectives. They remain neutral regarding the nature and direction of economic growth, and do not express an explicit preference for environmentally and socially sustainable innovations. This lack of explicit indication of an overall strategic direction is referred to as directionality failure.[8]

39. Accepting the Sustainable Development Goals as a strategic direction for STI implies revisiting the key priorities and scope of STI policy frameworks. STI policy for sustainable development must balance objectives of economic growth, social inclusion and environmental sustainability, with the 2030 Agenda providing broad directions of change to be supported by public intervention. To navigate the complexity of the Goals, STI policymakers can prioritize several of them or link them with their existing long-term development goals.

40. To become relevant for sustainable development in different social and economic contexts, STI policy should broaden its understanding of innovation to embrace a wider spectrum of technological and non-technological innovation. STI policy should consider innovation as a strategy with a potential to adapt to diverse levels of absorptive capacity across all economic sectors, ranging from technologically advanced sectors to traditional ones, including informal segments of the economy. Such policy should also recognize forms of innovation such as frugal innovation, grassroots innovation, social innovation or public sector innovation, all of which may be driven as much by economic concerns, as by social and environmental concerns.[9]

41. STI policymakers should strike a balance between providing support for a wide diffusion of proven technologies and processes requiring basic absorptive capacity in companies[10] and between fostering radical technological innovation and system-level changes with a potential of transformative impact but that require well-developed innovation and collaboration capacities and present a higher risk. The composition of an innovation mix to be supported by various STI policy instruments depends on the maturity of innovation systems and the nature of the challenge. Box 1 introduces various types of innovation, ranging from process improvement to transformative system innovation, and indicates their possible sustainability benefits.

Box 1

Innovation mix for sustainable development

Product and service innovation:

- Innovative technologies: enabling technologies, for example, ICTs, and technologies that underpin specific sociotechnical systems such as renewable energy technologies
- Innovative products: durable, reparable, re-usable, recyclable, biodegradable materials and products with reduced environmental impact
- Innovative services: (a) business-to-business services (provision of services aimed at improving processes of clients, for example, waste management, energy service companies and eco-design) and (b) business-to-consumer services (provision of services that are less resource intensive and reduce emissions, for example, extended warranties and repair services, and energy contracts adapted to marginalized groups)

Process innovation:

- Pollution control and pollution treatment technologies leading to health and

[8] KM Weber and H Rohracher, 2012. Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive "failures" framework. *Research Policy*, 41(6):1037–1047.

[9] E/CN.16/2017/2.

[10] For example, simple resource and energy-efficiency measures.

environmental benefits

- Waste prevention and waste management resulting in the following benefits: economic benefits (cost savings, new jobs), health benefits (prevention of health risks) and environmental benefits (prevention of illegal dumping of toxic waste)
- Resource-efficient processes leading to socioeconomic benefits (material energy and water savings, new jobs) and environmental benefits (reduction of environmental pressures)

Organizational innovation:

- Corporate social responsibility, for example, including this approach in company reporting
- Environmental management and auditing systems (for example, the Eco-Management and Audit Scheme of the European Union and standard 14001 of the International Organization for Standardization)
- Introduction of extended producer's responsibility solutions (corporate social responsibility)

Marketing innovation:

- Labels informing customer choices (for example, independently verified eco-labels or labels ensuring that the process of producing goods has respected human rights)
- Science-based campaigns and awareness raising of sustainable consumption

Business model innovation (single-actor models): innovative value propositions advanced by firms (for example, product sharing, functional sales)

Pro-poor and grass-root innovation: various types of innovation designed to address the needs of marginalized groups

Frugal innovation:

- Products designed or redesigned to reduce their complexity, while retaining their core functions
- Products often found in the informal sector, with a potential to reduce environmental impact throughout their life cycle due to reduced use of resources and energy, and re-use of materials and components

Social innovation: New collaborative arrangements with social and environmental benefits, for example, energy cooperatives, repair cafes and ecovillages

System innovation (multi-actor models): radical changes in product–service systems engaging with a group of functionally connected organizations such as the following:

- Multi-actor product-service systems, for example, product-sharing platforms and infrastructure
- Waste management systems (integrated approaches to collection, sorting, processing and disposal of waste, considering informal sector)
- Integrated mobility systems with reduced use of cars

Source: Adapted from Miedzinski et al., 2017a, An expert-based participatory evaluation of public policies for sustainability transitions, Conference paper presented at the Annual Conference of the European Forum for Studies of Policies for Research and Innovation, Vienna, 7–9 June 2017; Miedzinski et al., 2017b, Eco-innovation and resource nexus challenges: Ambitions and evidence, in R Bleischwitz, H Hoff, C Spataru, E van der Voet and SD VanDeveer, 2017, *Routledge Handbook of the Resource Nexus* (Routledge, New York); and E/CN.16/2017/2.

B. Science, technology and innovation as a challenge-driven policy domain

42. Opening STI policy frameworks to cross-cutting societal challenges and to new strategic priorities and types of innovation requires rethinking STI as a domain of public intervention. STI for sustainable development thus becomes a challenge-driven, cross-cutting, multi-actor and multilevel policy field. STI policy embracing societal challenges requires new linkages and synergies between STI policy and thematic or sectoral policies such as those relating to health, environment, agriculture and food or transport that are relevant to addressing specific societal challenges. Often, these policy areas already involve support for research and development and innovation, but they may have been pursued without explicit collaboration with STI policy or without considering cross-sectoral links between many areas relevant to sustainable development. Addressing complex cross-cutting issues, such as the water–energy–food nexus, requires lateral thinking and new governance arrangements and organizational reconfigurations implicating many ministries and levels of governance.

C. New actors of science, technology and innovation, and emerging governance challenges

43. In new STI policy frameworks informed by the 2030 Agenda for Sustainable Development, policymakers should engage with a wider variety of innovation actors beyond those usually involved in innovation systems, to include civil society groups, consumers, social entrepreneurs and grass-root organizations that are active in the informal economy. Policymakers should consider the role and implications of innovations for different communities, in particular with regard to the potential impacts on different ethnic, gender and generational groups.

44. Engaging new actors and facilitating new strategic collaborations requires political commitment, leadership and collaboration skills. Fostering STI collaboration focused on sustainable development requires coordinated actions by various government ministries and agencies, as well as key actors in the innovation system, including the private sector, research centres and civil society. Building a shared understanding and vision of how STI can help meet the Sustainable Development Goals and specific societal challenges is fundamental for mobilizing strategic partnerships and ensuring stakeholders' ownership and commitment to policy priorities. More ambitious innovation projects may call for policy experimentation and alternative governance models, which will complement, and in some cases gradually replace, established practices. There is a role for innovation spaces where experimentation and demonstration of innovation can be initiated and scaled, and social participation encouraged.

45. Transformative innovation can create tensions between advocates of change and incumbents. It requires strategic leadership and competences from policymakers, businesses and other leaders of the transition to anticipate and manage potential conflicts. Transformative change will challenge existing unsustainable practices. Policy should, on the one hand, withdraw incentives that may encourage firms and organizations to engage in unsustainable practices and on the other hand, provide incentives to innovate away from such practices.

D. Priority setting

46. Reorienting STI towards sustainable and inclusive outcomes involves changes in the priority-setting process. Notably, it implies linking STI policy frameworks with existing strategic documents and plans that establish national sustainable development goals. In this context, priority setting calls for the following actions:

(a) Assessing the potential of the innovation system to address the challenges;

(b) Assessing the potential of policy intervention to improve the capacity of the innovation system to address the challenges;

(c) Establishing a process for deliberation of STI priorities for sustainability that is evidence based, while engaging with a wide range of stakeholders with different interests that are fairly represented;

(d) Selecting areas with innovation potential in which common goals can be established and new partnerships built.

47. While STI policymakers should be able to design and implement specific policy instruments, it is critical that countries pursuing the Sustainable Development Goals build a strategic capacity to design and implement comprehensive and coherent instrument portfolios, or policy mixes, rather than focus predominantly on individual instruments.

48. For example, the challenge of climate change is unlikely to be met successfully by relying exclusively on market-based instruments such as carbon prices and emissions trading, and support for technology development. Limiting the impact of global warming may require stringent targets that impose limits on the current systems of production and consumption. In the long term, ensuring sustainability is likely to require more profound transformations of production systems and lifestyles patterns. Only a combination or a portfolio of mutually reinforcing policy instruments has a chance to create an impact and enable transformative innovation with a potential to substitute current unsustainable practices and systems. To be effective, STI policies should seek synergies with other policy areas and policy instruments relevant to the Sustainable Development Goals.

IV. Adapting UNCTAD science, technology and innovation policy work to the Sustainable Development Goals: A new approach to national policy reviews

49. The preceding discussion covers part of the background against which UNCTAD is currently reconsidering its approach to its activities in support of developing countries in the field of STI for development.[11] National STI policy reviews are the principal means of delivering that support. The reviews are an analytical and policy-learning process through which a country's STI stakeholders can reach a clearer understanding of the key strengths and weaknesses of their innovation systems and identify strategic priorities. The focus of the reviews is on employing STI to foster economic development. Further, they seek to contribute a strategic reflection and knowledge relevant to building productive capacity and improving the position of developing countries in the global economy (box 2).

50. STI policy reviews assume that participating countries have the strategic intent to make STI a key driver of sustainable development that enables a structural transformation of their economies. The reviews emphasize the importance of considering the specific context and capabilities of countries before making choices on development pathways to follow. They also recognize that there is no one valid model of development applicable to different countries but also that valuable lessons can be learned from the experiences of other countries and policymakers.

51. The reviews aim to assist countries in developing, assessing, trying out and implementing their own pathways of development towards meeting the Sustainable Development Goals. The framework underpinning the reviews encourages a systemic and evidence-based approach to address long-term structural societal challenges more effectively.

[11] A more detailed analysis that covers issues not presented here for lack of space, will be available in a separate publication. Examples include the differential characteristics of innovation systems at various stages of development, possible roles of specific policy instruments and implementation, and challenges in monitoring and evaluation.

Box 2
UNCTAD science, technology and innovation policy reviews

By assessing the effectiveness of current policies and identifying priorities for action for economic growth, and sustainable and inclusive development, STI policy reviews support STI policymaking in developing countries.

The reviews are undertaken at the request of member States. Following an extensive review of the country's STI system, an assessment is made, and policy options are drawn up and presented to STI policymakers and key stakeholders. All key STI stakeholders are involved through a process of consultations, including national STI policy review workshops. The outcome of this process is documented in a review that suggests recommendations for the consideration of the Government concerned. The review is disseminated through UNCTAD intergovernmental mechanisms, the Commission on Science and Technology for Development and among national STI stakeholders through workshops and other events.

The assessment and recommendations provide the basis for capacity-building activities designed to help lay the foundations for collaboration among STI stakeholders and address key capacity gaps identified in the process. Another important benefit of the review process is that it can help generate a consensus among STI policymakers and development stakeholders on future lines of action and can help establish a strong sense of ownership of the related policy programmes. As such, STI policy reviews can be considered a diagnostic element leading to a formulation of STI policy road maps with a marked orientation towards the Sustainable Development Goals.

UNCTAD has conducted 14 STIP Reviews in developing countries at different levels of development, and 2 more are under way. In several beneficiary countries, the reviews have promoted a significant revision of STI policies, helping to raise the profile of STI policy in national development strategies and facilitating the inclusion of STI activities in plans for international cooperation.

52. The framework of STI policy reviews is being redesigned to assist countries in aligning STI policy with the 2030 Agenda.[12] The overarching question of the reviews is to what extent STI helps tackle major societal challenges underpinning the Sustainable Development Goals and how STI policy can foster sustainable development based on synergies between economic development, social inclusiveness and environmental sustainability.

53. In line with the core mandates and expertise of UNCTAD, the new approach to such reviews should remain focused on the economic dimension of sustainable development. At the same time, the new approach should recognize that STI policies aimed at improving the productive capacity of developed and developing economies must prioritize innovations that promote economic development without compromising social inclusiveness and environmental sustainability. In this regard, the involvement in the review process of a broader set of actors, such as civil society organizations and community groups, should be enhanced to ensure a more inclusive consideration of the societal and developmental problems that should be addressed by STI.

54. In line with the considerations set out in sections III and IV of this note, it is proposed that the new generation of STI policy reviews should include the following new elements focused on sustainable development and in particular, the Sustainable Development Goals:

[12] For a description of the framework currently used in the STI policy review programme, see UNCTAD, 2011, *A Framework for Science, Technology and Innovation Policy Reviews: Helping Countries Leverage Knowledge and Innovation for Development* (United Nations publication, Geneva).

(a) An analysis of major sustainable development challenges facing the country under review;

(b) An assessment of the potential of innovation system to tackle selected societal challenges;

(c) An assessment of the country's STI performance in the areas relevant to the Sustainable Development Goals;

(d) An analysis of established and emerging innovation case studies relevant to the Sustainable Development Goals;

(e) An extended analysis of the role and performance of actors of STI, including new types of actors such as the financial sector, micro and small enterprises, civil society and the informal sector;

(f) Recommendations on short, medium and long-term STI policy objectives and road maps;

(g) Technical recommendations on monitoring and evaluation with indicators and targets allowing to measure progress towards sustainable development and the Sustainable Development Goals.

55. In combination with existing practice, the inclusion of these new elements should result in 10 key principles framing the overall conceptual and methodological approach to the process, products and desired outcomes of STI policy reviews under the new approach (box 3).

Box 3
The 10 principles of science, technology and innovation policy reviews

STI policy reviews are based on the following 10 principles:

1. Sustainability orientation: STI policy reviews are driven by the need to ensure that STI contributes to the long-term sustainable development goals of the country under review, in line with the 2030 Agenda for Sustainable Development and the Sustainable Development Goals.

2. Strategic reflection: The review process is designed to explore relevant alternatives for STI policy to address key challenges facing the country concerned. The process encourages a strategic reflection on the costs and benefits of alternative development pathways to achieve key development goals, and their implications for STI.

3. Policy orientation: The review process, findings and recommendations are fully aligned with the existing strategic STI policy framework and organizational setting and can be readily applied to the ongoing or planned policy processes in the country concerned.

4. Transformative impact: STI policy reviews focus on the potential areas of STI system, innovations and STI policy interventions that demonstrate strong potential for contributing to transformative change towards sustainable development and the Sustainable Development Goals in the local context.

5. Stakeholder participation: The STI policy review process engages with key government and non-government stakeholders to ensure that the analysis and recommendations are relevant and actionable. A broad representation of government, including various ministries and agencies relevant for STI, is included. UNCTAD reaches out to relevant non-governmental stakeholders, including firms and entrepreneurs, research and educational organizations, organizations financing research and innovation, donors and international development banks, and non-governmental organizations and grassroot organizations, especially those active in the informal sector.

6. Systemic thinking: The reviews are based on systemic approaches to the innovation process.

7. Contextual grounding: The reviews are designed to respond to the specific challenges, needs, competences and contexts of participating countries. Stakeholder involvement is crucial to ensure that advantages and limitations of the local context are adequately considered.

8. Evidence-based approach: The reviews are based on the best available evidence and expertise relevant for the review. The UNCTAD team follows a robust, flexible approach to ensure the use of good quality of quantitative and qualitative data relevant to the country context.

9. Independence: The review is an independent process led by a team coordinated by UNCTAD. Reviews do not seek to align with formal positions held by Governments and other stakeholders and contribute an independent assessment to the policy debate and policymaking process.

10. Policy learning: The review process and its follow-up are designed to encourage policy learning and exchange of experience among STI policymakers, stakeholders and the United Nations country team. The review is also intended to facilitate a policy discussion at the international level, such as the Commission on Science and Technology for Development, UNCTAD expert bodies and the Investment, Enterprise and Development Commission. The learning gained through the reviews should also facilitate the establishment of new international partnerships and collaborations in STI.

A. Methodological questions

56. Extending the scope of the STI policy reviews to embrace the challenges of sustainable development and the Sustainable Development Goals presents methodological and process implications. A revised framework for the reviews should be based on mixed methods and should rely on both qualitative and quantitative indicators. To enhance the transparency of the policy appraisal, specific review criteria should be identified ex ante.

57. The review process should include participatory methods, engaging with stakeholders and encouraging co-creation and experimentation. Efforts will be needed to build on local expertise by involving local experts and academics. This would contribute to building analytical capacity in beneficiary countries. The following table suggests examples of quantitative and qualitative indicators for consideration by the Expert Meeting.

Examples of quantitative and qualitative indicators for science, technology and innovation policy reviews

STI performance	Inputs	Business expenditure in research and development
		Public sector expenditure in research and development
		Seed, venture capital, equity investments (if possible by technology areas or sector)
		Foreign direct investment in knowledge-intensive sectors
	Activities and short-term outcomes	Share of companies involved in innovation activities (if possible by sector and size)
		Research and development personnel (sometimes considered an input)
		Technology adoption and diffusion (focus on technologies relevant to the Sustainable Development Goals)
		Scientific publications
		Patents
	Longer-term outcomes and impacts	Aggregate and industry-level productivity trends (labour, energy and resources)
		Sales of products new to the market (by sector and size of company)

Examples of quantitative and qualitative indicators for science, technology and innovation policy reviews

		Exports of medium- and high-technology products
		Social benefits (for example, employment in knowledge-intensive sectors and green economy sectors; quality of life and well-being)
		Environmental benefits (for example, greenhouse gas emissions, air quality improvements, pollution reduction and waste management improvements)
Innovation system	Actors and capabilities	Share of companies with process standards implemented (International Organization for Standardization)
	Linkages and networks	Qualitative evidence on networks (movements, associations or partnerships relevant to the Sustainable Development Goals)
		Labour mobility
		Scientific publications (co-publications and citations)
		Patent citations
	Framework conditions and enabling environment	Indicators on relevant dimensions of enabling environment, for example, level of education of society – share of population with higher education degrees, share of education with vocational education
STI policy mix	Strategic objectives	Existence of strategy dedicated to STI
		Existence of specific objectives and targets dedicated to STI
		Existence of strategy dedicated to STI for sustainable development
		Existence of specific objectives and targets dedicated to STI for Sustainable Development Goals and sustainable development
	Policy instruments	Existence and lifetime of various types of STI policy measures (mapping)
	Policy actors	Inventory of public bodies and other entities with involvement in STI policy formulation, implementation, monitoring and/or evaluation
	Policy design	Engagement of stakeholders in policy design (for example, existence and level of participation in public consultations)
	Policy implementation	Evidence on enforcement of regulations
	Policy coherence	Existence of dedicated bodies responsible for policy coordination (for example, number of meetings, ministries and agencies involved, level and nature participation)
	Policy evaluation	Share of operational or technical assistance budget devoted to policy monitoring and evaluation
		Types and number of evaluation studies
		Evidence of the use of monitoring and evaluation studies in policy design (for example, citations)

B. Key assessment criteria

58. STI policy reviews conducted by UNCTAD have mainly employed traditional criteria to assess the performance of the STI policies of participating countries. Relevance (the extent to which a given policy is likely to achieve the change in situation that is stated as its goal), effectiveness (the extent to which such changes have taken place and can be attributed to policy), efficiency (the relationship between the outputs delivered and the inputs required) and coherence (the extent to which a particular policy is supportive of other STI policies and of overall development policy) have been the most prominent criteria. To reflect the consideration of sustainability and inclusiveness in the reviews, there is a need to include specific criteria for sustainable development in the new framework. These would help policymakers understand the extent to which the existing STI policy framework responds to key questions such as its directionality, strategic alignment, legitimization, inclusiveness, distributional impacts or contribution to policy learning. Box 4 makes some suggestions in this regard.

Box 4
Assessment criteria focused on the Sustainable Development Goals

Agenda centrality: What is the position and relative importance of STI for sustainability in the policy debate and policy agenda?

Relevance: Are STI policy vision and objectives consistent with the priorities in the national development plans and adequate for the sustainability challenges faced by the country?

Directionality: Is the STI policy mix oriented towards sustainable development and the Sustainable Development Goals?

Policy stringency: Does policy protect marginalized groups and the environment?

Alignment: Does STI policy mobilize key stakeholders to engage in innovation activity relevant for sustainable development and foster innovation partnerships?

Legitimization: Do the choices about the direction of development pathways have a social mandate?

Experimentation: Does policy create strategic arenas for experimentation and demonstration of transformative system innovation?

Specialization: Does policy encourage STI specialization in the areas where STI policy is likely to achieve high impact and contribute to sustainable development?

Distributional impacts: To what extent does policy redistribute the costs and benefits of transition between societal groups and regions?

Policy evaluation and learning: Is policy based on scientific evidence and supported by a learning environment?

Source: Adapted from J Chataway, C Daniels, L Kanger, M Ramirez, J Schot and E Steinmueller, 2017, Developing and enacting transformative innovation policy: A comparative study, presented at the eighth International Sustainability Transitions Conference, 18–21 June 2017, Gothenburg, Sweden, available at http://www.transformative-innovation-policy.net/papers/developing-and-enacting-transformative-innovation-policy; Miedzinski et al., 2017a; J Schot and WE Steinmueller, 2016, Framing innovation policy for transformative change: Innovation policy 3.0 (draft version 2), University of Sussex, available at http://www.johanschot.com/wordpress/wp-content/uploads/2016/09/SchotSteinmueller_FramingsWorkingPaperVersionUpdated2018.10.16-New-copy.pdf; Weber and Rohracher, 2012.

59. Experts participating in the sixth session of the Expert Meeting are invited to consider how the issues presented in this note could be taken into account by UNCTAD in its revision of the framework for STI policy reviews, and more generally, in policy support to developing countries, in order to ensure a stronger contribution of STI policies to the achievement of the Sustainable Development Goals. Other issues for consideration are those relating to implementation, key research questions, modalities of stakeholder mobilization, as well as other issues that are not addressed because of lack of space.